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proper form for notes, suggestions for computations, and the probable error of the result are all given in a satisfactory manner.

Altogether, the book is a careful evidence of a thorough appreciation of the needs of engineering students and of the comprehensive knowledge of the distinguished author.

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PROFESSOR HEILPRIN ON MONT PELÉE.

THE twentieth century Pompeii in Martinique attracted men of science from all points of the compass. Notes have been published by Lacroix in Paris, Flett and Anderson in London and Hovey in New York, and magazine articles by Russell, Hill, Diller, Curtis and others have familiarized the public with the main facts. Two books of note have appeared, the one by a distinguished traveller and correspondent describing vividly and accurately a layman's impressions of the phenomena and the wreck. The second, entitled 'Mont Pelée and the Tragedy of Martinique,'* is by a well-known geologist and geographer, Angelo Heilprin, and his work is the first book that purports to be a scientific study.

The book was published in December, 1902, and the author had left the field only three months before. In view of this fact the work is a remarkable piece of rapid book-making, well executed by the publishers, and illustrated with half-tone photographs. It is essentially the journal of an explorer, with records compiled in the field of the disasters of May 7 and 8, and four scientific essays. The subjects treated are the author's impressions of Martinique, a description of the ruins of St. Pierre, the narrative of the last days of the city, the author's travels in the interior, his ascent of Pelée at the end of May and his second visit to Martinique in August. Professor Heilprin personally observed the great eruption of August 30, and from a distance he saw the eruption in St. Vincent September 3. His experience in August is especially valuable and unique, because at that time he kept the only scientific record.

* J. B. Lippincott Co., Philadelphia, 1903, pp. 336.

The scientific chapters deal with a comparison of St. Pierre and Pompeii, the geography of Mont Pelée, volcanic relations of the Caribbean basin and the phenomena of the eruptions. In the first of these Pliny's account of the Vesuvian eruption of 79 is discussed; Dion Cassius and later historians refer the destruction of life and property in Pompeii to 'ashes, cinders and gases. The tumble of ruins in Pompeii has commonly been attributed to earthquakes, but it is possible that there too a destroying blast annihilated the population almost instantly, as in St. Pierre; this accounts for bodies found in attitudes of action or indifference to danger. Heilprin questions the decapitation of Monte Somma at the time of the eruption of 79; he calls attention to Pliny's description of the phenomena as follows: 'On the land side a dark and horrible cloud charged with combustible matter suddenly broke and shot forth a long trail of fire in the nature of lightning, but in larger flashes.' And again, "I looked back; a thick dark vapor just behind us rolled along the ground like a torrent and followed us. The ashes now began falling, although in no considerable quantity." The similarity of this description to that of bystanders in the case of the Caribbean eruption is remarkable. The fact that Pompeian bodies are largely without clothing, and were huddled together in basements, and that pottery and glassware have been found deformed and discolored, suggests that there was a hurricane blast and conflagration similar to the one which destroyed St. Pierre.

It is questionable whether the Lac des Palmistes, on the summit of Mont Pelée, was really a crater lake. Heilprin concludes that the greater part of the water of this shallow pool after the first eruption was steamed off by the heated ejecta that were thrown into it. These are in part angular blocks of andesite, trachyte and diorite, with here and there scattered boulders of large size and composite character, representing the ancient stock of the volcano. This conclusion is a significant one, contrasted with the supposition of Drs. Flett and Anderson, who were sent out by the Royal Society, that a great

column of molten lava rose to the orifice and exploded. In this place Professor Heilprin apparently holds to the view that the materials ejected are comminuted country rock—an opinion heartily endorsed by the present reviewer. The crater is described as occupying the entire basin of the ancient *Étang Sec*, and this lay in a gorge distinct from that other head-water tributary of the *Rivière Blanche*, known as the *Rivière Claire*, where in 1851 a number of vents opened and ejected ashes. While this is doubtless true, it is probable that all these gorges are now united in the present great amphitheater filled by the new cone. Professor Heilprin recognizes the difficulty attending all surmises as to the exact location of the opening whence came the destroying blast; but he believes it most probable 'that the blast issued from the basal floor of the basin, rather than from a constructing cone.' He states that the lower discharges were always more violent and paroxysmal than those from the upper cone, and that they carried the heaviest charges of ash, sometimes to heights of two miles or more. In this there is no suggestion of a vent low down on the mountain slope, but merely the difference between the base and the summit of the new cone. Violent discharge from the side of the cone has also been noted by Lacroix, and this characteristic is a common one; the ancient crater of *Soufrière* in St. Vincent, as described in the chronicles of 1812, had a central cone and lakes at the side. The present crater in St. Vincent, when visited by the reviewer on May 31, showed most violent activity on the southeast side of the great cauldron, rather than in its middle. In the center beneath the boiling waters of the pool, there is probably to-day a cone similar to the one on *Mont Pelée*, representing the direct back-fall of the heaviest materials ejected vertically.

In discussing the volcanic relations of the Caribbean basin, Professor Heilprin follows Suess in the belief that the Caribbean Sea is comparable with the Mediterranean as an area of depression, surrounded by mountain ridges, the islands of the Antilles being in the main merely disrupted parts of a once 'continuous land area.' It is hard to follow

him confidently when he states that the volcanic activity of these islands belongs 'to a period of no great geological activity—perhaps nowhere more ancient than the middle tertiary.' Hill has shown clearly that in miocene time there was the most notable orogenic movement in tertiary Caribbean history, and active vulcanism dates probably from the beginning of the eocene. The Suess theory that the Caribbean-Gulf basins are great subsiding areas which 'break, squeeze and press, and as a resultant lands are folded up and volcanic discharges brought to the surface,' is simple and attractive, but in no way proved. The same may be said of the philosophy which links volcanic eruptions on one side of an ocean, with earthquakes on the other that chance to be contemporaneous, or nearly so. It is strange that a colossal seismic disturbance that would bring about correlated phenomena in Guatemala, St. Vincent and Martinique should have no effect whatever on other vents along the same line of fissures as those of these islands. It seems safer to regard such large generalization with a distrustful eye, and to keep in mind earth scale when we speak of 'the outer crust or shell of the globe as resting on a molten interior.' The horizontal scale of the Caribbean Sea, in proportion to the vertical relief of the tiny volcanic blisters, is so enormous that it seems safe to treat the little volcanic fissures very superficially. We know nothing of the earth's 'interior,' nor even of a 'shell.' All that geologists know of rocks can hardly be called a film, in proportion to the great unknown globe within. While the author's view on these points may be open to question, we entirely agree with his opinion that there is no evidence of any recent decrease of volcanic activity in the Caribbean region, and he might well go further and question whether there has been diminution since prehistoric times; human time, like human measure of space, is inadequate for determining such a question.

In the discussion of the phenomena, presumably the statement on page 272 that the 'sweep of the blast could not have been less than from one to two miles an hour' is a

misprint. The statement that 'pumice and bombs prove the existence of a molten magma which rises well into the throat of the volcano,' may be questioned, for ancient glassy tuffs and pumice are abundant in the old agglomerates of Martinique, and the bombs are old rocks merely melted on the surface. The estimate of amount of ash sediment discharged, based in part on Russell's expression of the cubical content of a steam cloud, is full of fallacy. The argument is as follows: If a single cloud has a capacity of four billion cubic feet, is charged with one per cent. of solid matter, and is regularly replaced every five minutes by another cloud of the same size, the total discharge of solid matter per day is 11,520,000,000 cubic feet. This is one and a half times the discharge of the Mississippi River per year, and on this basis the discharge of Pelée is greater than that of all the rivers of the world combined, for the same period of time. This argument is concluded with the question, 'what becomes of the void that is being formed in the interior?' The defect in this sort of reasoning lies in the assumption that a primary eruption is continuous for days or even hours. There have been a few moments of violent outburst at certain intervals, which were undoubtedly explosions from great depth, and may be called primary eruption. Secondary explosion continues for weeks in the intervals, and is occasioned by the contact of superficial water and hot deposits. Obviously such explosions are only working over the same material, yet they occasion tremendous puffs that rise many thousand feet, and perfectly simulate deep-seated processes. Professor Heilprin has failed to discriminate primary and secondary eruption when he talks of Mt. Pelée being 'in a condition of forceful activity for upwards of 200 days.' The reviewer questions whether the volcano has been forcefully active from great depths for that many minutes. There have been eight or nine considerable eruptions, and probably none of these lasted more than five or ten minutes. There is no probability of a void in the interior; there is a fissure system, and with the removal of material from the walls, there is probably collapse that is

compensated so gradually by subsidence over a wide area, that it makes no appreciable effect even on the height of shore lines.

As a whole the book is a good exposition in popular style of the main facts connected with the Caribbean eruptions of 1902. There are not sufficient maps to make all geographical matters clear, and there is a lack of diagrammatic illustration, much needed to make intelligible certain explanatory or theoretical statements. The scientific results of Professor Heilprin's research would be more easily grasped if they were tabulated; he will doubtless compile tables in more technical forms of publication. His summary of the phenomena, and the description of events in August which came under his immediate observation, will stand as records of permanent value to vulcanology.

T. A. J., JR.

SCIENTIFIC JOURNALS AND ARTICLES.

THE opening (January) number of Volume 4 of the *Transactions* of the American Mathematical Society contains the following papers: 'Orthocentric properties of the plane n -line,' by Frank Morley; 'Definitions of a field by independent postulates,' by L. E. Dickson; 'Definitions of a linear associative algebra by independent postulates,' by L. E. Dickson; 'Two definitions of a commutative group by sets of independent postulates,' by E. V. Huntington; 'Definitions of a field (Körper) by sets of independent postulates,' by E. V. Huntington; 'On the invariants of differential forms of degree higher than two,' by C. N. Haskins; 'Über die Reducibilität der Gruppen linearer homogener Substitutionen,' by Alfred Loewy; 'The quartic curve as related to conics,' by A. B. Coble; 'The cogredient and digredient theories of multiple binary forms,' by Edward Kasner; 'On the envelopes of the axes of a system of conics passing through three points,' by R. E. Allardice; 'A Jordan curve of positive area,' by W. F. Osgood.

THE December number of the *Bulletin* of the American Mathematical Society contains: 'Concerning the commutator subgroups of groups whose orders are powers of primes,' by W. B. Fite; 'Note on irregular determinants,' by L. I. Hewes; 'Note on the projec-